NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

A REQUIREMENT ANALYSIS FOR THE NAVAL POSTGRADUATE SCHOOL'S ALUMNI DATABASE SYSTEM

by

Lawrence M. Gaines

September 2002

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REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503.

1. AGENCY USE ONLY *(Leave blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	September 2002	Master's Thesis

4. TITLE AND SUBTITLE A Requirement Analysis of the Naval Postgraduate School's Alumni Database System

5. FUNDING NUMBERS

6. AUTHOR (S) Lawrence M. Gaines

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Naval Postgraduate School
Monterey, CA 93943-5000

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the U.S. Department of Defense or the U.S. Government.

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT *(maximum 200 words)*

Currently the Naval Postgraduate School's Alumni Database houses the records of nearly twenty-six thousand alumni, however there are over fifty thousand more records that need to be added. Although a database currently exists that attempts to fulfill many of the requirements of an alumni system, it has been determined that overall the current database is inadequate. A need exists to either modify or replace the current system to ensure that all of the Naval Postgraduate School's alumni relation needs are met. A decision is being pondered about whether the creation and management of such a system should be done within the confines of the school or should it be outsourced to another organization. This thesis will aid in that decision making process. Throughout this study, evaluations are made on the feasibility of having an alumni system, and the most cost effective way to obtain it. Assessments and recommendations are also made on issues involving security, accessibility, and the responsibilities of the system's users, as well as the system. In its entirety, this thesis will serve as a foundation for those deciding on the fate of the Naval Postgraduate School's attempt at creating and maintaining an effective and efficient alumni system.

14. SUBJECT TERMS Database Requirement Analysis			15. NUMBER OF PAGES 102
			16. PRICE CODE
17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	UL

NSN 7540-01-280-5500 **Standard Form 298 (Rev. 2-89)**
Prescribed by ANSI Std. 239-18

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A REQUIREMENT ANANLYSIS FOR THE NAVAL POSTGRADUATE SCHOOL'S ALUMNI DATABASE SYSTEM

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Submitted in partial fulfillment of the
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MASTER OF SCIENCE IN INFORMATION TECHNOLOGY MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
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ABSTRACT

Currently the Naval Postgraduate School's Alumni Database houses the records of nearly twenty-six thousand alumni, however there are over fifty thousand more records that need to be added. Although a database currently exists that attempts to fulfill many of the requirements of an alumni system, it has been determined that overall the current database is inadequate. A need exists to either modify or replace the current system to ensure that all of the Naval Postgraduate School's alumni relation needs are met. A decision is being pondered about whether the creation and management of such a system should be done within the confines of the school or outsourced to another organization, this thesis will aid in that decision making process. Throughout this study, evaluations are made on the feasibility of having an alumni system, and the most cost effective way to obtain it. Assessments and recommendations are also made on issues involving security, accessibility, and the responsibilities of the system's users, as well as the system. In its entirety, this thesis will serve as a foundation for those who will determine how the Naval Postgraduate School will proceed in finding a solution to its alumni needs.

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ACKNOWLEDGEMENTS

I would like to thank everyone who helped in the completion of this thesis. I would like to especially thank my advisors Julie Filizetti and Dr. Daniel Dolk for all of their assistance.

Finally, I sincerely thank my two daughters, Morgan and Sydney, for knowing when to allow daddy to study, and my wife Dwan for being a rock and handling all the responsibilities required in allowing me to complete yet another chapter in my career.

Without all of your contributions this would not have been possible, thank you.

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I. INTRODUCTION

A. BACKGROUND

Established in 1909, the Naval Postgraduate School began as a small graduate school specifically designed to educate military officers. Through its transition from Annapolis, Maryland to Monterey, California, and throughout its existence there have been thousands of students who have matriculated at the institution. Since most of these graduates have served, or will continue to serve in many different military and civilian capacities, therein lays a valuable reservoir of knowledge waiting to be accessed. This knowledge is important to the Naval Postgraduate School for several reasons that range from conducting alumni surveys to generating ideas and answers to various research issues. Over the past fifteen years various attempts have been made to construct a way to access this knowledge and to stay connected with the graduates, however, a glaring void still exists in this arena.

Currently, there is no effective medium that exists that allows the Naval Postgraduate School's staff and faculty to stay connected with the school's alumni. Naval Captain Jeff Kline of the Graduate School of Operations and Information Science, Dean Douglas Brook of the Graduate School of Business, and Naval Commander Sue Higgins, a faculty member in the Space Systems curriculum, agree that by having an effective system, all departments within the school would be able to obtain more feedback on real world issues and problems that dominate the business world, as well as the fleet. Dean Brook also suggests that tracking how well the school is progressing as a learning

institution would also be easier to accomplish with a more effective system available. He notes that although some processes may be accomplished by the current system, the advantages created by a more diverse and user-friendly system would be nearly limitless.

Group mail-outs to alumni and former staff, as well as daily, weekly, or monthly updates of the changes being made at the school would also be an activity greatly facilitated by a more effective system. Presently the possibility of these updates being done by one central system does not exist, however they are being attempted through various means that are seen by only a small fraction of its intended audience. With a new and more effective system, files would be managed and maintained electronically which would allow for greater accessibility, usability, and visibility.

Additionally, Amy Crain of the Naval Postgraduate School Foundation estimates that because of the current system's inability to foster relationships and connections, the Naval Postgraduate School Foundation, Incorporated has missed the opportunity to raise hundreds of thousands of dollars in fundraising and donations, donations that could be used for things such as supplementing student housing costs or assisting in guest speaker costs. She estimates that with a competent and effective system in place, fundraising could reach nearly seventy-five percent more potential donors than are currently being reached. This increased outreach would not only benefit fundraising totals, but would also establish a connection where other information could be shared.

B. RESEARCH ISSUES

From these areas of concern it is evident that a void still exists in the Naval Postgraduate School's alumni system. This thesis will focus on filling that void by detailing requirements for a Web-enabled alumni information system that will allow the executive staff, faculty, and alumni of the Naval Postgraduate School to stay connected even after they have departed from the institution. In order to create such a system, however, several problems must be addressed and resolved.

- How to design an effective and user-friendly system.
- Identify who the main stakeholders of the system are, and how they will interact with the system.
- How to evaluate the costs and benefits of outsourcing such a system compared to developing the system in-house.
- Determine which alternative best accomplishes the goals of the Naval Postgraduate School.
- How to design a system that allows for group modifications to be accomplished and information to be shared amongst its users.
- How to design a system that can interact with other NPS systems.
- How to design a security structure to safeguard the integrity of the data.

C. METHODOLOGY

To gain knowledge on how alumni information was acquired and maintained in the past, several research techniques were used. Because much of the history surrounding the Naval Postgraduate School's alumni system is not well documented, a significant number of telephone and personal interviews were conducted to solicit

information and knowledge about past and future systems. Interviews were conducted ranging across the spectrum from representatives of potential outsourcing companies to key representatives of the major stakeholders that have a specific interest in the development of the system. Internet resources, books written that were relevant to this topic, previous theses, and other relevant publications were also used to gather preparatory information.

Research was done to design a system that allows group modifications, and also to design a system that allows for information to be shared, maintained, and accessed by multiple users.

Determining who will utilize the alumni database, how it will be used, and the responsibilities of those using the system are also major issues surrounding the implementation of a new system. An important deliverable of this thesis is the description of all the major participants in the process and how they will interact with both the system, and one another. As a result of stakeholder interviews and research of past usages and requirements, we have developed use cases, which are textural narrative descriptions, for each of the main usages for this system and have documented user responsibilities in ensuring that the system is adequately maintained. We have also developed actor/use case diagrams that illustrate the interactions between the users and the system on a daily or weekly basis. Access criteria have also been produced to determine who requires access to the system and what types of access they will be granted.

The ability of the new system to relate and interact with other systems is another concern that has been addressed. Because of the diversity of the Naval Postgraduate School's systems, led by the PYTHON Student Management System, measures need to be taken to ensure that any alumni system that is designed needs not only to interact with the important existing systems, but should also be able to replace many of the ad hoc and legacy systems that are being used to extract and utilize alumni information campus-wide. This can only be done if a concise, user-friendly system is created. A study was conducted to determine the levels of compatibility that the alumni system must have to coexist with other NPS systems, and how its development may result in other departments discontinuing the usage of their ad hoc alumni systems.

Also, a survey was conducted to determine if there was any interest in having a new system introduced. A cost-benefit analysis was also conducted to determine if the costs of creating a new system was feasible for the school. In the study, the benefits and costs of maintaining and managing the system in-house are compared to outsourcing that responsibility to an outside agency.

When designing an interactive database that primarily contains information about military personnel, the need for security is patently obvious. Research was done to both identify the inherent risk associated with this project, and to identify the risks that are a part of all interactive Internet projects. This thesis offers possible solutions to address and mitigate the risks that are associated with this subject.

D. STRUCTURE OF THE THESIS

Following the conclusion of this chapter, the thesis will flow in the following sequence. Chapter II will chronicle the history of past attempts made at building an adequate system. A snapshot will be provided that details past submissions and their shortfalls. Chapter III will focus on whether the need even exists for an alumni system. Survey results will be provided to illustrate that potential users feel that there is a need for the system at the school. Also, cost-benefit analysis results will be provided to show the potential advantages and disadvantages of the system, and the options currently being explored to get the usability of the system back to an acceptable level. Chapter IV will take a look at how the actual system should look and be set up. Information will be provided detailing how the system will interface with the current systems at the Naval Postgraduate School, specifically the PYTHON Student Management System. Use cases will be provided to establish a guideline for how users will interact with the system, and how the system will respond to those actions. Also, access criteria will be provided along with a list of user responsibilities to show the different access levels, what that level will entail, who should be granted that level, and their responsibilities to the system. Questions concerning security will be presented with possible solutions to mitigate concerns. In chapter V, we summarize the work accomplished, provide a list of system requirements, and conclude with other system recommendations.

Over the past fifteen years a significant amount of progress has been made in constructing a flexible and

effective alumni system, however to date, no system has been designed that ensures that alumni information is centrally located, easily accessed, easily modified, and easily managed. This thesis will attempt to bring the Naval Postgraduate School closer to that goal.

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II. HISTORY OF THE ALUMNI DATABASE SYSTEM

For many years the Naval Postgraduate School has struggled to find ways to locate and remain connected with those who have attended and graduated from the school. In an effort to provide a point of reference for how the Naval Postgraduate School's Alumni System has evolved over the last couple of decades, a brief snapshot of its history is provided in Figure 1. Although many of the details of previous systems will be excluded, some of the problems encountered by those systems will be shown to provide further evidence of why an updated or new system is needed.

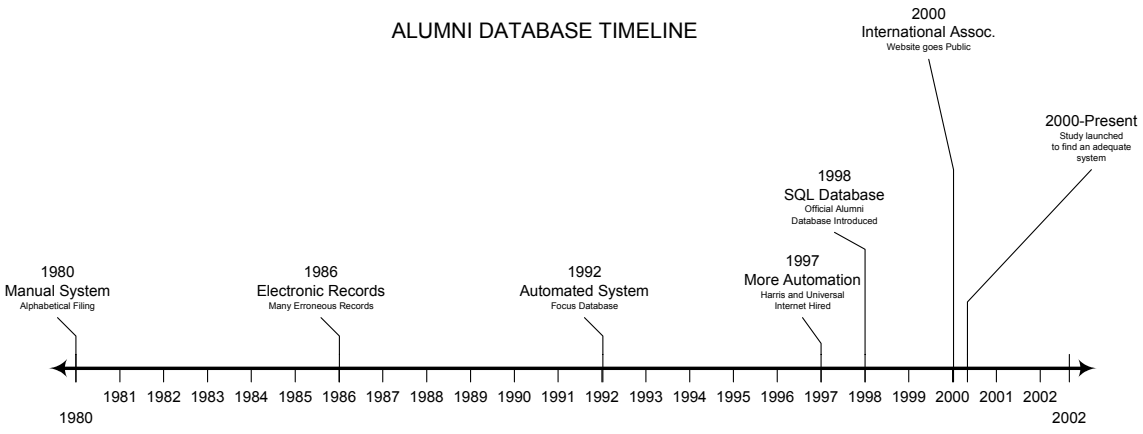

Figure 1. Alumni Database Timeline

The Naval Postgraduate School's first known foray into the alumni relations arena came in the early 1980s, which is when the school instituted its first alumni management system with the intent of staying in contact with the school's graduates. The manual system that was designed and implemented during that time turned out to be very

tedious, inefficient, and difficult to manage. The majority of past and present student records that were maintained were kept alphabetically in filing cabinets located in the Office of the Registrar. When it was determined that a record required modification or cancellation, attempts were made by the Registrar's Office to make the necessary changes, however because the records had to first be located, and then manually updated, often times the changes never occurred. Several factors contributed to this inefficiency, but most frequently this lack of progress resulted from an inadequate amount of personnel, and the sheer volume of the records that had to be searched to locate those requiring adjustments. This resulted in thousands of records that were either outdated or invalid.

In 1986, the school made a second effort to address the alumni situation. It decided that maintaining the records of all the graduates electronically rather than manually would better prepare the institution for the future. During the fall of 1986, the Office of the Registrar started keeping electronic records of all the Naval Postgraduate School graduates. Although the burden of having enough physical space to house all the records had been lifted, several challenges still existed. One problem resulted from the conversion of paper records to electronic ones. The combination of incomplete and inaccurate material contained in the hard copies along with user input error resulted in the database being heavily populated with erroneous data, which is still evident in the current system. Also, the time and effort it took to convert the records played a key role in delaying the

system's usability. It would have required nearly around-the-clock input by several clerks to convert the approximately forty thousand existing records; therefore many records are still only available in hard copy format.

By the end of the 1980's users realized that they still were not getting what they wanted or needed from the system, so in 1992, after attempting several manual and electronic alternatives to contact past and present graduates, another effort was made to automate the entire alumni system. The project turned out to be quite extensive and involved several organizations, primarily the NPS Office of the Registrar, the NPS Alumni Association, and the NPS Foundation. These entities, along with several others, tried to create an NPS alumni database that would not only store all of the alumni records, but also allow for the completion of many different functions ranging from printing simple reports to running basic information queries. In late 1992, the official NPS Alumni Database was established and made available to the school's alumni. The system had been designed utilizing a Focus program and was expected to be more effective and efficient than previous attempts. In addition to having extensive storage capabilities and the ability to complete basic functions, the database was intended to easily accommodate both record modification and cancellation; unfortunately this was never accomplished. Although this system solved some of the problems that previous systems did not address, the system still did not allow records to be searched using designated fields. Also, records could still only be accessed on an individual basis. Although modifications to individual records could be done, they were difficult to

accomplish, and the ability of make group modifications was still not available. The system was also not very user friendly; in fact the Deputy Associate Provost stated that, if a user did not have significant knowledge about Focus, he believed it was virtually impossible to extract meaningful data out of the system. Although this particular attempt proved to have very limited capabilities, it did have a positive impact on the development of later systems. This failed system laid the groundwork necessary for future attempts at designing an effective alumni system.

Following the lead of other prestigious graduate level institutions, NPS leaders recognized an increasing need to establish alumni connections, so in 1997 an Alumni Relations Office was established. Because the existing system at that time did not allow the Naval Postgraduate School the access that it wanted or needed, another attempt was made in 1998 to get a handle on the alumni problem by creating a relational database that utilized Structured Query Language (SQL). This database was intended to incorporate all the alumni-related information made available from several sources around campus and to store it in one general location. To populate this database system, information would be supplied from several sources:

- The Focus database that had been used in the early 1990's. The information from this database would be used to supply data about present students, as well as the limited number of graduates that had been entered into the system. Although this system had not performed well, much of its information had proven to be reliable; therefore it was transferred to the relational system.

- Outsourcing. Bernard C. Harris Incorporated, a computer service company, had been hired by the school to conduct a poll to locate past graduates whose manual records had been deemed incomplete or inaccurate. Harris' findings, once verified, also served as a source of information for this database. Universal Internet, another computer firm, who had been hired by the NPS Alumni Association to work on creating an alumni management system, also had pertinent information that needed to be transferred to the relational database.
- The Alumni Relations Office. The ARO had been maintaining information on current students and recent graduates by maintaining manual checkout and update sheets, and was also supplying the relational database with information.

With this wide variety of information being supplied by several sources, the job of those commissioned to develop the relational system became increasingly difficult. Furthermore, soon after the project began, many of the NPS leaders who had initiated the process were beginning to transfer or retire, which caused a lapse in momentum and direction.

Once modifications to the system began to occur, a bevy of new expectations began to surface. One of the most important changes that developed from this turnover was the evolving definition of an alumnus. The new leaders decided that not only should the new system track students obtaining master degrees, but it should also incorporate those students who were attending and eventually graduating from one of the many short programs that the school offered. In addition to traditional master's degree students, graduates of these short programs were now going to be considered school alumni as well. This new

definition and requirement deterred many faculty members and caused the scope of the project to increase to the extent that most involved believed that a valid system could not be created or accurately maintained.

In March 2000, the NPS Alumni Association, in conjunction with Universal Internet, launched the International Alumni Association website, which provided access to the alumni database. This relational database was much like its Focus predecessor, and it addressed many of the problems that had existed, however there were still other issues not being adequately addressed. One issue of great importance was that the relational database did not have robust search capabilities. According to Alumni Relations Office, this system was also not very user friendly. This was primarily because the system was being geared toward fundraising. Although the school's alumni were the main focus in this system, many others, such as retired military and interested civilians, were also included in the database. This frequently caused confusion and problems for the system's users. Also, without having prior knowledge of relational systems or how to structure search criteria, users found it difficult to retrieve desired information.

Another problem that surfaced involved the various sources of information that were being utilized. Because the information that the system was intended to use came from several places, problems arose around the lack of standardization in the way records were being maintained. Because some records were stored utilizing student names, and others were stored utilizing file numbers or social security numbers, the system and its users were

understandably confused. There were no standardized fields common across the various sources and this resulted in corruption of the system and its ability to provide meaningful and truthful data.

Later in 2000, the Alumni Relations Office began conducting studies looking at ways to create a more efficient and effective alumni system. During this process it was realized that while the SQL system had served as a significant stepping-stone in the overall alumni process, something else was needed to take alumni relations to the next level in accessibility, maintainability, and manageability.

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III. ANALYSIS OF FINDINGS

In the early stages of its development in the 1980's, the Naval Postgraduate School's Alumni System was faced with several challenges. Because those in charge of making crucial decisions in determining its implementation were skeptical, supporters of the system were required to document reasons why they felt it was necessary, and the added value that it would provide to the institution. In 2000 that entire process seemed to go full circle as Naval Postgraduate School leaders again asked those committed to an alumni system to justify the need for having a new or updated one, and again supporters began preparing explanations of why the system was, in their eyes, important and necessary. NPS officials were asking the tough questions because, prior to obligating more money to an ineffective system, they were trying to ensure that an updated or new system was really beneficial to the school. They wanted to understand the value that the system might generate, and to determine how much the system would cost. Over the course of the past year, we conducted interviews and mailed out surveys that address these specific questions.

A. SURVEY: PURPOSE

A survey was mailed out to individuals at the Naval Postgraduate School that either had experience in using past alumni systems, or a significant interest in the creation of a more effective system. The fifteen individuals selected to participate in this survey are listed in Figure 2. These individuals were identified by

members of the Alumni Relations Office to be key representatives of the major stakeholders in the Naval Postgraduate School Alumni System.

NAME	TITLE/DEPARTMENT
Christopher Arias	Student Services Officer, SSO
Tracy Hammond	Deputy Associate Provost, Registrar
Amy Crain	Director of Operations, NPS Foundation
Danielle Kuska	Director of Research Administration
Rudy Panholzer	Dean, GS of Eng. & Computation
Jeff Knorr	Professor & Chairman, Eng.& Computation
Bill Hatch	Acad. Assoc., GS of Bus.& Public Policy
Jeff Kline	Associate Dean, GS of Info. Science
Charles Calvano	Professor, GS of Mechanical Engineering
Rob Bourke Jr.	Alumni Relations Officer
Sue Higgins	Military Faculty, Space Systems
Douglas Brook	Dean, GS of Bus. & Public Policy
Gary Roser	Director of International Programs
Bob Osterhoudt	President, Alumni Association
Julie Filizetti	Exec. Director of Institutional Advancement & Communications

Figure 2. Survey List

The key representatives were asked several questions on the importance of an alumni system. Responses were ranked on a scale from 1 (least important) to 5 (most important) in order of importance, and are listed in Figure 3.

Do you feel an alumni system is needed at the Naval Postgraduate School?

- Definitely Needed 60%
- Greatly Needed 20%
- Somewhat needed, but not required 20%

How much will an alumni system be used by you and/or your department?

- Daily 20%
- Weekly 40%
- Sparingly (few times a month) 40%

Would an alumni system impact your job and responsibilities?

- Significantly 20%
- Somewhat 70%
- Not much 10%

Quantify the potential usages for the system?

- Limitless 20%
- Very few limitations 60%
- May have some limits, but not significant 20%

Would you promote using the system?

- Yes, would require it 60%
- Yes, would strongly suggest it 40%

Figure 3. Survey Results

A list of important intangible features for an alumni system was generated from interviews that were conducted and research that was done. Individuals surveyed and interviewed were also asked to rank, on a scale from 1 to 10, the importance of having these intangibles in a potential alumni system. The results are listed in Table 1.

FACTOR	Jeff Kline	Amy Crain	Bill Hatch	Danielle Kuska	Rudy Panholzer	Jeff Knorr	Tracy Hammond	Julie Filizetti	Charles Calvano	AVERAGE
Accuracy	10	10	10	10	10	10	5	10	9	**9.3**
Reliability	8	10	10	10	10	10	5	10	7	**8.9**
Ease of Use	9	10	8	6	8	8	5	8	8	**7.8**
Affordability	5	8	5	6	6	10	5	9	*	**6.8**
Interoperability	7	*	8	8	5	5	3	8	*	**6.3**
Scalability	5	*	5	7	4	8	5	7	*	**5.9**
Paperwork Reduction	6	5	5	5	5	8	1	8	*	**5.4**
AVERAGE	**7.1**	**8.6**	**7.3**	**7.4**	**6.9**	**8.4**	**4.1**	**8.6**	**8.0**	***no value recorded**

Table 1. Critical Success Factors

Although the survey is not a statistically designed instrument, it does provide preliminary indications that an alumni system is needed. Many of the respondents to the survey and those interviewed indicated that they believe that not only is an alumni system needed, but it is mandatory if the school wants to continue to be a competitive graduate institution. Also, many of the participants in the process indicated that such a system could have a noticeable effect on how they performed their job and the level at which it was performed. Although the

majority of those surveyed said that they would sparingly utilize the system, it is easy to infer that others with different responsibilities and interest may have an increased need to use the system. Most also felt that the system was nearly limitless in ways in which it could be used and the effect that it would have on the school. Some feel that past alumni systems have failed because of a lack of interest and because of how old systems were promoted. According to the survey results, if an effective product is developed, promotion or the lack thereof would be a non-issue. Many of the participants indicated that they would not only promote the usage of the system, but would require it.

Although the survey results provided indications of the potential an effective system might have, the results were not conclusive. This suggests that further requirements analysis as is warranted. Accordingly, the next step we undertake is a cost-benefit analysis. An economic analysis is a systematic approach to evaluating alternative projects. Underlying such an analysis is the base assumption that each alternative may be able to solve an existing problem and should produce certain results while requiring and utilizing certain resources. In this particular situation, there are several options being considered to solve the problem. An economic analysis was performed on each of these options to determine the comparative costs and benefits, and to determine which alternative is the most appealing from this perspective.

B. COST-BENEFIT: PURPOSE

There are several options being considered for the alumni database system at the Naval Postgraduate School. They include:

- Updating and utilizing the existing SQL relational database
- Outsourcing the creation, population, hosting, and management of the system to one of the following vendors:
  - Bernard C. Harris Publishing Inc.
  - Sungard BSR
  - JSI Fundraising Inc.

The Naval Postgraduate School Alumni Database, a SQL relational database, is the system currently installed at the Naval Postgraduate School for alumni relations. The problems with this system are extensive and have been detailed in previous chapters. In short, the system contains several shortfalls, primarily with its usability and adaptability. It has also become outdated and will not allow important processes to be successfully completed that are necessary in today's alumni environment. One option being considered to address the alumni system problem is updating the SQL system that currently resides at the school. There are several advantages and disadvantages to this option and these will be discussed later.

Outsourcing the management of the alumni database to an organization outside of the Naval Postgraduate School is another distinct possibility being considered. At the outset of this thesis, there were several corporations that were being considered for the job, since then however, the possible contractors have been whittled to the three corporations listed above. These three companies have

provided information that indicates that they may have the ability to furnish NPS with an adequate alumni system.

C. DISCUSSION

All options were analyzed by utilizing the following methodology:

- An assessment of the advantages and disadvantages of each option.
- A cost breakdown of each option and comparison across options.
- An evaluation of the intangible factors as they apply to the options.
- A calculation of the Net Present Value (NPV) for each option.

The following data were used to calculate NPV for all options:

- Discount Rate: 10% (when evaluating investment projects that will continue for more than three years in a government organization, discounting should be used if at all possible. The prescribed Department of Defense discount rate for evaluating alternatives is 10%).
- Initial Costs: paid upfront at “Time Zero”
- Recurring Costs: paid at the beginning of the year, starting in year 1
- Life Cycle: 5 years
- Scrap Value: zero for any hardware used

1. Option 1: Updating the Existing SQL Relational Database

This option involves updating the SQL relational database that currently exists. The chief advantage in

this option appears to be the costs associated with revamping the currently ineffective system. Familiarity is another advantage of this option. Because the system has evolved into its present state, those who have been around and understand how to use it are comfortable and should be benefited by utilizing a system they know. However, the advantages of this option could very easily become disadvantages if the work required to make the system an adequate one is more labor intensive than currently expected by those familiar with the system. The possibility of having NPS graduate students take on the project was considered, however it was determined by a panel headed by members of the Alumni Relations Office that this option required a significant amount of time to organize and implement, which made the option not feasible.

The disadvantages of selecting this option are considerable. The primary disadvantage of updating the SQL system is that the expertise needed to create and maintain such a system in-house currently does not exist and is unavailable here at the school. Although updating the system would address some of the current system's problems, several others will continue to remain unless a significant amount of money is spent to make the system error-free.

The approach used to assess this option uses estimated costs of maintaining and updating the SQL system, manpower operating costs, and the processing of all paperwork associated with the system. The cost analysis for this option is displayed in Tables 2-4. There is a hint of subjectivity on all assessments, however, all assessments made are based on individual interviews, interviews of potential outsourcing companies, and research.

Factor	Assessment	Average	Computed Value
Accuracy	4	9.3	37.2
Reliability	5	8.9	44.5
Paperwork Reduction	3	5.4	16.2
Interoperability	6	6.3	37.8
Ease of Use	3	7.8	23.4
Affordability	9	6.8	61.2
Scalability	6	5.9	35.4
TOTAL		7.2	**255.7**

Table 2. Intangible Factors for Option 1

TOTAL COST

FIXED

ITEM	UNITS	PER UNIT	TOTAL
Software Upgrades, Licensing			$ 3000
Hardware Upgrades			$ 2000
			$ 5000

RECURRING

ITEM	UNITS	PER UNIT	TOTAL
Database Analyst (GS-7)	1	$ 35000	$ 35000
Maintenance			$ 5000
Software			$ 1000
Hardware			$ 1000
			$ 42000

TOTAL COSTS **$ 47000**

Table 3. Total Cost for Option 1

NET PRESENT VALUE

FIXED COSTS $ 10000

INITIAL COSTS (Paid this year) $ 5000

RECURRING COSTS

Operating Costs $ 37000

Time	Absolute	Discounted
0	$ 47000	$ 47000
1	$ 47000	$ 42723
2	$ 47000	$ 38822
3	$ 47000	$ 35297
4	$ 47000	$ 32101
5	$ 47000	$ 29187

NET PRESENT VALUE **$ 255130**

Table 4. Net Present Value for Option 1

2. Option 2: Outsourcing; Bernard C. Harris Publishing Inc.

This option has the potential to be very beneficial to the Naval Postgraduate School because Bernard C. Harris Inc. is very experienced in providing services to many of the nation's premiere educational institutions. Harris' expertise in this field is not easily matched, and selecting this option could garner a significant "bang for the buck". In its proposal, Harris vows to create a new system for the Naval Postgraduate School that will account for all of the requirements and risks associated with the project, and they will do so at a relatively inexpensive

price. In addition to offering a catered system, Harris has also indicated that they will assign technicians who will be solely dedicated to the Naval Postgraduate School's new system. Another advantage is that Harris has committed to doing what it terms as a "search and locate" for all past alumni whose records presently do not exist. This service is included in Harris' price quote.

Many of the disadvantages of outsourcing the project to Harris is similar to the disadvantages of other outsourcing projects; loss of control to the vendor, reduction of in-house competency due to vendor dependency, and lack of security. A major inherent risk in outsourcing a project that involves military officer information is security. Harris proposes that it will alleviate all NPS security concerns, and adhere to DOD security criteria.

The approach used to assess this option, in most instances, uses prices furnished by the company and commercial industry prices for hardware. Estimates are used to account for manpower costs when applicable. Fees submitted by Harris did not project past current year, therefore future year costs are estimates. The cost analysis for this option is displayed in Tables 5-7.

Factor	Assessment	Average	Computed Value
Accuracy	9	9.3	83.7
Reliability	8	8.9	71.2
Paperwork Reduction	7	5.4	37.8
Interoperability	7	6.3	44.1
Ease of Use	8	7.8	62.4
Affordability	9	6.8	61.2
Scalability	8	5.9	47.2
TOTAL		7.2	**407.6**

Table 5. Intangible Factors for Option 2

TOTAL COST

FIXED

ITEM	UNITS	PER UNIT	TOTAL
Data Entry Fee			$ 5600
Email Address Append			$ 1700
Search and Locate Service			$ 7700
			$ 15000

RECURRING

ITEM	UNITS	PER UNIT	TOTAL
Maintenance, software, hardware			$ 22400

TOTAL COSTS **$ 37400**

Table 6. Total Cost for Option 2

NET PRESENT VALUE

FIXED COSTS $ 15000

INITIAL COSTS (Paid this year) $ 22400 ($11200 at contract, $11200 at delivery)

RECURRING COSTS

Operating Costs $ 22400

Time	Absolute	Discounted
0	$ 22400	$ 22400
1	$ 37400	$ 33997
2	$ 37400	$ 30892
3	$ 37400	$ 28087
4	$ 37400	$ 25544
5	$ 37400	$ 15863

NET PRESENT VALUE **$ 156783**

Table 7. Net Present Value for Option 2

3. Option 3: Outsourcing; Sungard BSR

This is a second option in outsourcing the system to an outside organization. A major advantage of the Sungard software is its robustness. Sungard's latest release in the market is the 8.2 version of its Smartcall system. Sungard has forecasted version 9.0 being released within the next year. Serving over twenty-thousand clients worldwide and forty-seven of the world's top fifty largest financial institutions, Sungard has definitely established itself in the unique systems market, which provides solid evidence that the company is up to the challenge of handling the requirements of the Naval Postgraduate School.

Sungard's Advanced System is a Windows based system that can utilize either a UNIX, Windows NT, or Windows 2000 server running MS SQL Server, or Oracle 8.0.6 or higher.

A major disadvantage of Sungard option lies in the cost associated with purchasing the system. Although Sungard would be able to accommodate the NPS requirements, things such as an online directory, additional technical support, and alumni website construction would require additional funding. These costs, in addition to other inherent outsourcing issues, cause this option to compare unfavorably with other options.

The approach used to assess this option also uses prices furnished by the company and commercial industry prices for hardware. The cost analysis for this option is displayed in Tables 8-10.

Factor	Assessment	Average	Computed Value
Accuracy	10	9.3	93
Reliability	9	8.9	80.1
Paperwork Reduction	10	5.4	54
Interoperability	8	6.3	50.4
Ease of Use	10	7.8	78
Affordability	4	6.8	27.2
Scalability	9	5.9	53.1
TOTAL		7.2	**435.8**

Table 8. Intangible Factors for Option 3

TOTAL COST

FIXED

ITEM	UNITS	PER UNIT	TOTAL
Advance			$ 54800
Licensing			$ 12000
			$ 66800

RECURRING

ITEM	UNITS	PER UNIT	TOTAL
Maintenance			$ 23300
Internet Interface			$ 9900
			$ 33200

TOTAL COSTS **$ 100000**

Table 9. Total Cost for Option 3

NET PRESENT VALUE

FIXED COSTS $ 66800

INITIAL COSTS (Paid this year) $ 54800

RECURRING COSTS

Operating Costs $ 37000

Time	Absolute	Discounted
0	$ 54800	$ 54800
1	$ 100000	$ 90900
2	$ 100000	$ 82600
3	$ 100000	$ 75100
4	$ 100000	$ 68300
5	$ 100000	$ 62100

NET PRESENT VALUE **$ 433800**

Table 10. Net Present Value for Option 3

4. Option 4: Outsourcing; JSI Fundraising, Inc.

This is the third option for outsourcing the maintenance and management responsibility of the Alumni System. The advantages of this option relate to JSI's track record in the fundraising arena. The company founded in 1978, promotes its new Millennium fundraising software as the solution to many of the Naval Postgraduate School's alumni problems. The sophisticated and versatile software is a Windows based product that is designed for educational institutions much like NPS, in fact several reputable educational and medical institutions are currently using it worldwide.

The disadvantages of this option, in addition to those inherent in outsourcing, are that JSI specializes in fundraising and that is only a fraction of what an NPS alumni database will be required to do. Although JSI asserts that their system and staff can accommodate the requirements, their level of expertise in other areas required by the NPS system is questionable. Another disadvantage to the JSI proposal is that no plan was given to search and locate information about those alumni who currently do not exist in the database. If an effort were made to capture this information, it would have to be coordinated with another organization. Although JSI would provide significant advantages in fundraising, at first blush, the system that they propose does not seem flexible enough to handle all of the Naval Postgraduate School's requirements. Additionally, fundraising is not a priority of the Naval Postgraduate School.

The approach used to assess this option also uses prices furnished by the company and commercial industry prices for hardware. The cost analysis for this option is displayed in Figures 11-13.

Factor	Assessment	Average	Computed Value
Accuracy	7	9.3	65.1
Reliability	7	8.9	62.3
Paperwork Reduction	7	5.4	37.8
Interoperability	8	6.3	50.4
Ease of Use	6	7.8	46.8
Affordability	6	6.8	40.8
Scalability	6	5.9	35.4
TOTAL		7.2	**338.6**

Table 11. Intangible Factors for Option 4

TOTAL COST

FIXED

ITEM	UNITS	PER UNIT	TOTAL
Millennium			$ 29000
User license			$ 6750
License for Oracle			$ 5000
			$ 40750

RECURRING

ITEM	UNITS	PER UNIT	TOTAL
Browser Interface Module			$ 10000
Maintenance			$ 8600
			$ 18600

TOTAL COSTS **$ 59350**

***Total Cost does not include cost for "search and locate" requirement.**

Table 12. Total Cost for Option 4

NET PRESENT VALUE

FIXED COSTS	$ 40750	
INITIAL COSTS (Paid this year)	$ 40750	
RECURRING COSTS		
Operating Costs	$ 29000	
Time	Absolute	Discounted
0	$ 29000	$ 29000
1	$ 59350	$ 53949
2	$ 59350	$ 49023
3	$ 59350	$ 44571
4	$ 59350	$ 40536
5	$ 59350	$ 36856
NET PRESENT VALUE		**$ 253935**

Table 13. Net Present Value for Option 4

D. SUMMARY

Initial Cost Comparison. The initial costs of modifying the current SQL system appears to be easily the most inexpensive of the options. However, because the current system will require such an extensive overhaul to get it to an acceptable level and to make it technically competitive with other options, modifying the system is not a logical choice. The next best choice, according to the initial cost statistics, is outsourcing the system to Bernard C. Harris Publishing Inc.

Total Cost Comparison. Outsourcing the system requirement to Harris is the best choice in terms of the

total cost involved. Totaling $ 37,400, this option's nearest competitor totaled $9,600 more. Not only does this option have the most inexpensive costs, but it also has the lowest net present value. Again, although the Sungard system will provide many advantages, the total cost for selecting this system is the most expensive option considered.

Comparison of the Intangibles. In the category of intangibles, the system offered by Sungard proved to be the highest scorer. With a total rating of 435.8, it is easy to understand why Sungard seems to be such a great fit for the Naval Postgraduate School. Modifying the current SQL system attained the lowest score of any of the options. Although the SQL option provided lower costs, the factors that are important to the stockholders probably will not be accommodated by the system. In the intangibles, Bernard C. Harris, Inc. was very competitive with Sungard as it obtained a rating of 407.6. JSI Inc. finished third with a rating of 338.6. A chart of all the options is listed in Table 14.

SUMMARY COMPARISON			
OPTION	**INTANGIBLE VALUE/ AVERAGE FACTOR**	**TOTAL COST**	**NPV**
1(Update DB)	255.7 / 5.1	$ 47,000	$ 255,130
2(Harris)	407.6 / 8.1	$ 37,400	$ 156,783
3(Sungard)	435.8 / 8.7	$100,000	$ 433,800
4 (JSI)	338.6 / 6.7	$ 59,350	$ 253,935

Table 14. Summary/Comparison of Options

E. RECOMMENDATIONS

As previously noted, there are several important factors that have an affect in determining which option provides the best fit for the Naval Postgraduate School. Although the overall cost of the system seems slightly more important than the intangibles, a comparison of a combination of the factors will decide which option is the most advantageous.

Although JSI Inc. was not the leader in any of the categories presented, its expertise in fundraising and its experience with other educational institutions make it a reasonable option in the decision making process. However, JSI's lack of experience in other areas where an alumni database could be used, and its inability to accommodate "search and locate" procedures on approximately 20,000 alumni not currently present in the Alumni Database, make this option less desirable.

Modifying the current SQL system is the most advantageous option with regard to initial costs and it is very competitive in total costs. However, this option is severely lacking in the intangibles, and since it is highly questionable if the expertise that is required to create and maintain the system is available at NPS, we believe this option is high risk and therefore inferior to other alternatives.

Sungard offers a great product with a proven track record. The major problem with the system is its relatively high price. Although this system seems to be a great fit for the Naval Postgraduate School and excels in the intangibles, Sungard's total cost of $100,000 and its net present value exceeding $ 400,000 significantly reduces its desirability.

Outsourcing the installation, population, and management of the Naval Postgraduate School's Alumni System to Bernard C. Harris Publishing, Inc. seems to be the most desirable choice according to the established evaluation criteria. On all fronts, this option is either the leader or is very competitive with the other options in every category. Harris, much like Sungard, has a proven product that has earned a solid reputation. With the lowest total costs and net present value of any of the options, and a very high score in the intangibles, we recommend that the Naval Postgraduate School pursue this option as its solution to an alumni system.

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IV. SYSTEM REQUIREMENTS

A. STAKEHOLDERS

Now that we have determined that outsourcing the creation and management of the Alumni System in the near term is the most desirable option, we have system requirement issues that must be addressed. First, we must identify the key stakeholders in the system. The main stakeholders who have a vested interest in the design and implementation of an effective and efficient alumni system are listed in Figure 4.

MAJOR STAKEHOLDERS
Alumni Relations Office (ARO)
Alumni Association
Naval Postgraduate School Alumni
Office of the Registrar
Department of International Programs
Naval Postgraduate School Departments
Student Services
Naval Postgraduate School Foundation

Figure 4. Major Stakeholders

B. USE CASES

Throughout the requirements analysis for the alumni system, we employ use cases, which are narrative documents that describe the sequence of events that occur when a system and user interact. Succinctly, use cases are stories or cases of how a system is used by its customers. In constructing the use cases input was obtained from many of the system's potential users, as well as its potential creators and managers. Many of the use cases provided within this thesis are basic function use cases, which show the essence of the alumni process and its fundamental motivation without providing an overwhelming amount of design detail. We decided that use cases were needed to ensure that the overall process was well understood and could be reviewed if required. A series of expanded use cases is provided in the appendix in Tables 17-27.

C. DATABASE SCHEMA

Also throughout performing the requirement analysis for the alumni system, a database schema was constructed. Although the schema provided should not be viewed as a final submission, it does establish a framework for future databases. Database schemas basically define the structure of a database. Schemas combine tables, relationships, domains, and the business rules that will be used in the database's functions, and they serve as foundations upon which database applications are built. In designing the database schema for the alumni system, input was solicited from potential system users and managers. Those individuals were asked questions that pertained to what type of alumni information was most important to them, what

reports were expected to be generated by the system, what queries were expected to be performed, and what they would like to see the database be able to accomplish. What resulted was the schema shown in Figures 5 and 7. The schema presented consists of twelve tables that will store all of the required data. Data requirements are listed for each of the tables, as are the relationships that connect them. The Alumni Table, located within the schema, will store the largest amount of data, as it will serve as the focal point of the entire system. The alumni data required ranges from social security number to military branch of service. The primary key in this table will be AlumniID. The Alumni Table is where most of an alumni's personal data will be stored, and is the table that will probably be used most frequently. The Address Table is designed to store the alumni's current address. The table contains AddressID as its primary key. This table has a one-to-many relationship with the Alumni Table because one alumnus can have many addresses. The Undergraduate Table is designed to store all of the alumni's undergraduate data. This table will store the alumni's undergraduate university name, the type of degree attained, and the year graduated. In this table the primary key is UndergraduateID. This table also has a one-to-many relationship with the Alumni Table. The Donations Table is established to monitor the alumni's donation history. The primary key in this table is DonationsID. This table also has a one-to-many relationship with the Alumni Table. The AlumnusDegreeType and AlumnusCurric Tables are join tables in this schema. Join tables are established to act as conduits that allow data to be more easily transmitted between tables.

Relationships between these tables and the Alumni Table are one-to-many. The DegreeType Table will store data about the degree that the alumnus attained while attending the school. DegreeTypeID is the primary key in this table. This table has a one-to-many relationship with the AlumnusDegreeType join table. The Curriculum Table is designed to store the alumni's curricula information when he attended the school. The primary key in this table is CurricID. This table has a one-to-many relationship with the AlumnusCurric join table. The Track Table is designed to store data on the alumni's degree track. Some NPS fields of study can contain several tracks that can be pursued, this table will store this data as it pertains to an alumnus. The primary key in this table is TrackID. This table has a many-to-one relationship with the Curriculum Table. The Status, State, and Country Tables in the schema are all look-up tables. Look up tables store and provide access to static data that is required in the database. These tables will be used to acquire the status (active duty, reserve, retired, deceased) of an alumnus, and the state and country of residence. The alumni database schema is shown if Figure 5.

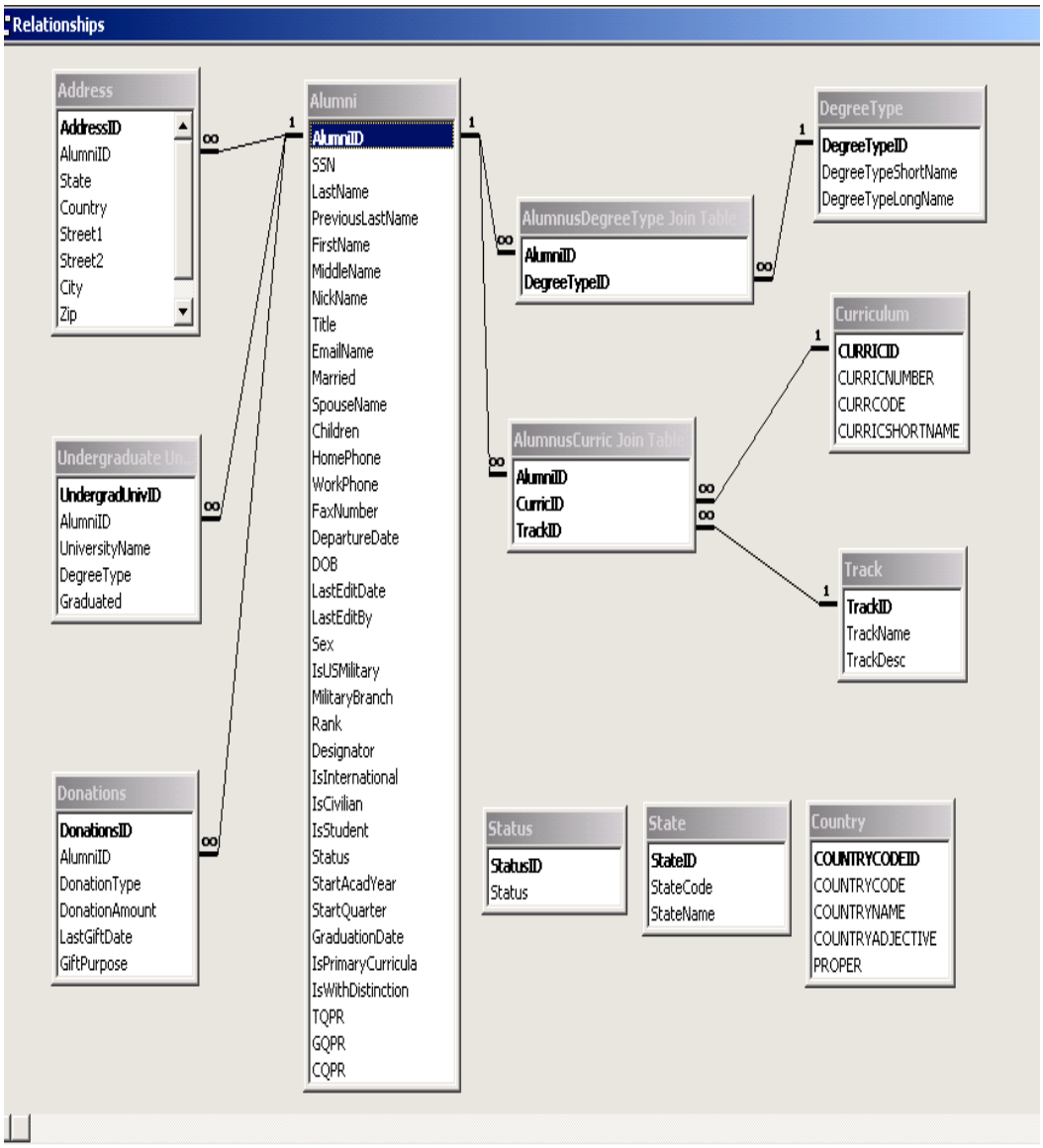

Figure 5. Database Schema

D. SECURITY ISSUES

The issue of system security is clearly an obstacle that must be addressed prior to implementation of any contracting decision. In this project, as with many other

Internet endeavors, there are several security risks that can compromise system integrity.

1. Authentication

One of those potential hurdles is authentication. Because of the nature of the data that will be secured in the Alumni System, the ability to authenticate users is a vital element in this system. There are several authentication methods that are available for this type of system and each carries comparative advantages and disadvantages. In evaluating the possible solutions for the Alumni System, three methods will be studied to determine which provides the best fit: Basic Access Authentication, Digest Access Authentication, and Secure Socket Layer Authentication.

Basic Access Authentication is a part of the Hypertext Transport Protocol (HTTP). In this scheme, the user must authenticate himself with a user ID and password to access each realm of the system. Within each realm, protected resources are partitioned off with their own authentication databases. When a request is made for a document that belongs to a protected space, the server will require the user to authenticate himself, and then a browser will prompt the user for an ID and password. If this information is validated, the user will be allowed to access the data that he is requesting. Once authenticated, the browser remembers the ID and password, so that when another data request is made, the user will not have to be prompted again. The user IDs and passwords utilizing this scheme are stored in an encrypted form.

The advantages to using this authentication approach in the Alumni System primarily involve ease of use. Users will find this method very easy to use because it is what most users are accustomed to. This type of authentication is installed on most web server and browser software.

A disadvantage to utilizing this method is that it is difficult to manage. If the Alumni System employed this method, each server being used would have to issue and securely store an ID and password for each user. Additionally, usernames and passwords would have to be prearranged manually by a system administrator, which could become a very time consuming process. Also, because the process would be a manual one, the possibility of inputting erroneous material would be increased. A major disadvantage of this scheme is that IDs and passwords would be transmitted over the network in the clear. This would permit eavesdroppers to relatively easily obtain the information necessary to breach the system. Basic Access Authentication is also susceptible to DNS and IP spoofing. Because clients have no way of authenticating the server, they are prone to security attacks. With the proper equipment, anyone with a strong desire to access the system can easily do so when this scheme is employed.

Combining IP addresses and domain names with Basic Access Authentication offers a more acceptable approach. By employing these techniques, the Naval Postgraduate School could restrict access to the alumni servers by permitting only those requests that come from within its own domain to enter. This approach, however, might limit participation, especially since many of the proposed system’s users would be located around the world. Using

the IP addresses and domain names in concert with Basic Access Authentication would make it more difficult to spoof the system, however the ability would still exist to penetrate the system, and subsequently there would be no guarantee that the person contacting the server is who he claims to be.

These shortcomings render this authentication method, if used alone, inadequate for the Alumni System. Although the Basic Access Authentication scheme may keep away the casual surfer, it will not protect against those really wanting to gain access to the system.

Another authentication method available to the Naval Postgraduate School Alumni System is Digest Access Authentication. This scheme is much like Basic Access Authentication, but it avoids the glaring weakness of sending passwords in the clear. This scheme also uses the challenge-response method, however, nonces are used to prevent replay attacks by possible system hackers. A nonce is a parameter that varies with time. Frequently used nonces are things such as time stamps and visit or usage counters on web pages. Because nonces change with time, they are used to limit or prevent unauthorized replay or reproduction of a file. Nonces make it easier to tell whether an attempt at replay or reproduction is legitimate. In Basic Access Authentication if an eavesdropper obtains a password, he normally has access to everything that is under the umbrella of that password, but in Digest Access Authentication an eavesdropper would only obtain access to that particular transaction, not the password or other information accessible by that password. In short, the eavesdropper could implement a replay attack, but it would

work only with a request for the same document, and even this could be made difficult with a well-selected nonce. Another advantage to this method is that the HTTP server does not actually need to know the user's clear text password. As long as the checksum of the user ID, the realm, and the password is available to the server the authorization header can be verified and validated.

A possible drawback to this would occur if the password files are compromised, which would then give the hacker immediate access to all documents in that specific realm. There are other disadvantages to the Digest Access Authentication scheme as well. Like Basic Access Authentication, the user name and password in Digest Access Authentication must be prearranged in some fashion, which again may be very time consuming and error-prone. Also Digest Access Authentication is susceptible to man-in-the-middle attacks. This happens because there is no way for clients to authenticate servers in this scheme. Man-in-the-middle attacks are relatively simple; they usually happen when an attempt is made to coax the client into giving up its password. An example of this might occur after the server has received the client's request and is issuing a challenge. A hacker, or middleman, could intercept that challenge and issue another one. Not knowing this spoof has occurred, the client would issue a response that contains the user name and password, which in turn, would give the hacker access to the system. A final disadvantage to this scheme is that it cannot be used for any transaction that requires encrypted content, which would severely limit the Alumni System.

Although Digest Access Authentication addresses some of the concerns that Basic Access Authentication does not, it is still considered a weak authentication method. Digest Access Authentication will normally keep away the casual surfer and the mediocre hacker, but when used alone it still lacks in the ability to protect valuable information.

A third authentication method is the popular Secure Socket Layer (SSL). This scheme was specifically developed to provide privacy and data integrity by using encryption and message authentication codes. SSL is designed to provide security for protocols like HTTP, FTP, and TELNET by interposing themselves between TCP and higher-level protocols. SSL allows client/server applications to communicate in a way that prevents eavesdropping, tampering, or forgery. One way that this scheme is used is when an application is summoned by the SSL to set up a channel. During the SSL handshake protocol, public key cryptology is used to authenticate the communicating parties and exchange session keys. An example of how this would be used in the Alumni System would occur when a user prompts the client to send the server a message requesting access. The server would send a certificate, which would include the server's public key, and the client would create a session key and send it encrypted in the server's public key so that only the server could access it. The remainder of the transmission would be encrypted utilizing the session key. Besides protecting against spoofs, another advantage of SSL is that it is application independent. This means that higher-level protocols can layer on top of the SSL protocol transparently. Also, SSL

is very adaptable, which is important to the Alumni System. Because it is easy to modify or add support to SSL, SSL can easily accommodate a significant increase in the number of browsers. Using a strong authentication method such as SSL is an adequate way to protect the information being exchanged in the Alumni System. This scheme would be especially useful when credit card donations and other highly secure and confidential transactions are being transmitted in the system.

Increased security in the Alumni System can be realized by combining two or more of these three schemes. In choosing an authentication method that best serves the requirements of the Alumni System, not only authentication of the user and server, but also the integrity of the message and the degree of confidentiality should be considered. Obviously there is no single best scheme that will totally protect the system from all hackers, however our recommendation for providing an acceptable level of security is to utilize the SSL scheme to protect users who are transmitting secret material in the system, augmented by a form of Digest Access Authentication to assist in that protection. We believe this combination will give the Alumni System a secure platform to exchange information and ideas over the Internet.

2. Passwords, Backups, and Packet Filtering

Other security issues that may cause concern in the Alumni System are weak passwords, poor system back-ups, and no packet filtering.

Passwords are a key element in the utilization of the Alumni System. Unfortunately, the use of passwords comes

with the baggage of security breaches resulting from compromise of those passwords. Normally passwords are a system's first line of defense against intruders; this is also true in the Alumni System, so it is imperative that users understand the importance of passwords. To eliminate or mitigate the ability for users to install weak passwords, or passwords that are easy to hack, a program should be installed that rejects any password change that does not meet the Alumni System's parameters. These parameters should contain requirements such as changing passwords on at least a semiannual basis, ensuring that passwords are not reused, and ensuring that passwords are made up of more than just alphanumeric characters. Efforts should also be made to ensure that passwords are adequately designed, so that they will be of the length and composition required to make guessing and cracking difficult. Users should be given ample notice and guidance on the creation and utilization of passwords. This will eliminate difficulties and bad passwords when updates are required. Utilization of password-generating tokens, such as smart cards, is also an option in this system. This is an easily installable and very reliable option when compared to the traditional password. Unfortunately because of the costs involved and the nature of this system, this option is neither feasible nor practical. We recommend that the Naval Postgraduate School implement an Alumni System that requires users to be selective in the creation of their passwords. Software should be installed that sets forth the minimum criteria required for all passwords, and also checkpoints should be established that detail when new passwords should be created.

How and when to back up data is a potential data integrity problem for the Alumni System. Unfortunately when an incident occurs in most organizations, recovery from the incident requires up to date backups, which are usually not as current as needed. With the Alumni System, backup policies and procedures should be clearly defined. Although the exact size of the potential system is unknown, it is estimated that annually the system's size and depth will continue to increase and will possibly approach the gigabyte range in the future. Although much of the data housed within the database would not change very often, because of the number of potential users, it is recommended that backups be done on a daily or at least weekly basis, and periodic checks be made at least monthly to ensure that information is being stored in an adequate and usable form. Instituting this backup policy should ensure that the requirements for the Alumni System are met.

3. Firewalls and Application Gateways

Other system requirements that need to be addressed as they relate to security in the Alumni System are firewalls and application gateways. To assist in helping to protect the network from attacks, a firewall should be installed in the Alumni System. These hardware and software combinations create narrow channels through which information flow can be tracked and controlled. Firewalls can usually deter most individuals who are trying to obtain unauthorized access, and at the very least they can warn of an attack or attempted attack. The firewall should be installed on a dedicated high performance workstation that is located outside of the LAN but inside of the router link

to the Internet. The important thing to remember here is that all traffic should pass through this firewall. The firewall that is implemented should include packet filtering, which is usually carried out by the router as data packets pass through the router's interface. When the router receives a packet, it examines the IP destination address in the packet header and forwards the packet to the next stage. Packet filtering, if properly implemented, can act as a line of defense between the network and the Internet, which makes it relatively easy to filter out unwanted traffic at the router.

In addition to firewalls that contain packet filtering, application gateways should also be used to provide more security to the Alumni System. An application gateway screens incoming data that is based on more than just the contents of a packet header. These hosts funnel approved users to the appropriate application server. An advantage of an application gateway is that it is usually inexpensive and less complex to manage. The combination of packet filtering and application gateways will provide additional security to the Alumni System.

In addition to a firewall and an application gateway, we also recommend that a firewall monitor be used with the system. Firewall monitors will be able to detect potential problems before they become actual ones. They will be able to log application gateway usage and be able to report who is using the system and what they are using it for. These monitors can also assist in password security.

E. ACCESSIBILITY

A major concern of those interested in the construction of an Alumni database is the issue of who should have access to the system and how much access they should have. After conducting an ample amount of research by way of interviews, surveys, and studying past systems, the following access levels were established for potential system users. A list of access levels and explanations are provided in Table 15, and a summary of recommended access levels for each stakeholder is provided in Figure 6.

Level/Ability/Explanation

Level 1. Read Only. Although users with this access level may utilize the system on occasion, the ability to make changes to the system should not be granted. Having this level of access will allow records to be viewed. Persons requiring this level of access would normally be office clerks.

Level 2. Read and Modify. With this access level, users will be able to perform all things listed under Level 1, as well as have the ability to make modifications to previously existing records. Persons requiring this level of access are: school alumni (on their own record), department heads, and executive staff, NPS Foundation.

Level 3. Read, Modify, Create, and Delete. With this access level nearly all functions of the database can be utilized. In addition to having the access cited in Level's 1 and 2, Level 3 users will also have the ability to create and delete records. Because this level involves a high degree of security, this access level will be restricted. Persons requiring this level of access are: Personnel of the Office of the Registrar, Alumni Relations Staff

Level 4. Total Access. With this access level everything available in the system is accessible. In other access levels there are some fields that will be hidden from the user, however this level will contain no hidden fields. Those given Level 4 access are granted system administrator responsibilities. Persons with this access level will be able to grant or deny access to potential users of the system. Because of the responsibility and security involved with this level, it will be restricted. Persons requiring this level of access are: Alumni Relations Officer, Executive Director of Institutional Advancement and Communications

Table 15. Access Description List

MAJOR STAKEHOLDER ACCESS LEVELS	
Alumni Relations Office (ARO)	Level 4
Alumni Association	Level 2
Naval Postgraduate School Alumni	Level 2
Naval Postgraduate School Foundation	Level 2
Office of the Registrar	Level 3
Department of International Programs	Level 2
Naval Postgraduate School Departments	Level 1 & 2
Student Services	Level 2

Figure 6. Major Stakeholder Access Levels

F. INTERACTION WITH OTHER NPS SYSTEMS

Another key issue that must be addressed is how the Alumni System will interact with current Naval Postgraduate School systems. To ensure that effective and efficient integration is achieved, the proposed Harris system will utilize its Data Exchange System to transfer data between its Online Directory and the Naval Postgraduate School's databases. Clear and regular communication between these entities is necessary to ensure that a complete and accurate transfer of data is obtained. Prior to submitting the initial data file to Harris, several parameters will be defined by the Naval Postgraduate School to ensure that the data requirements are understood. The discussions will define the plan for the Online Directory Database plus

format the initial file and subsequent files transferred to, and obtained from, Harris. Once the submission is understood and accepted, data exchange will begin. As users make updates to the system, a daily report will be created, maintained, and provided to the Naval Postgraduate School. All data will be exchanged through a Harris secure file transfer site and will be made available to the school. To ensure that adequate security is maintained, the Online Directory will be made available only to those users who register for access to the system. The registration process requires user authentication that will attempt to prohibit unauthorized usage and viewing. During the authentication process, alumni will be required to search the database for their profile, and once their profile has been found, they will be required to enter a unique security code identifier. It is recommended that the name and the last four digits of the social security number or international identification number be used. Only after this is verified will users be allowed to establish IDs and passwords in the system for future usage. Harris will physically maintain the Online Directory Database on a secure server, while NPS representatives will be responsible for maintaining the content of the database through data transfers.

An example of how the alumni system will interact with other Naval Postgraduate School systems is depicted in an example of how the school will conduct its Schieffelin Award process for the school's best teacher. Annually the school solicits nominations and input from its alumni and other participants regarding potential recipients of its best teacher award. Currently this process is not very far

reaching because many of the school's alumni are not contacted. The proposed system however, will greatly affect this process. At the onset of the award process, profiles of potential nominees (name, title, department, accomplishments/research, etc…) will be compiled from PYTHON and stored in a PYTHON table that is linked to the alumni database. A Naval Postgraduate School staffer would then specify a target audience based upon Online Directory fields. Once this information is validated, the staffer would then utilize a broadcast email application located within the alumni database to publish the information to alumni. Within the email, each respondent will be directed to an online ballot, wherein they will be requested to vote for faculty members who were their instructors when they attended NPS. The ballots and instructors are linked (transparently to voters) to the PYTHON database, which collects and tabulates statistics from the ballots to be presented to the Schieffelin Award Committee. An expanded essential use case for this process is provided in the appendix in Table 28.

F. RESPONSIBILITY

Along with having accessibility to the system, users will also be required to perform several tasks to assist in the accuracy of the system. A brief list of user responsibilities to the system is listed below.

1. Level 1

Because of the limited capabilities involved with this access level, there are limited responsibilities as well.

Users with Level 1 access are required to point out informational inaccuracies when they are noted in the system. They should also indicate system problems that are experienced during normal use.

2. Level 2

As with access criteria, the responsibilities of the previous level will be included in the next level's responsibility, so in addition to the responsibilities of Level 1 users, which is to ensure the accuracy of the system, Level 2 users are required to enter only accurate and verified information into the system. In the event that an error is discovered, persons with this level of access are required to correct the information or forward it to the next highest level. Because many of the school's alumni will be granted this level of responsibility it is important that accurate and updated information be emphasized. Because of the large number of potential records that could be stored in the Alumni System, level 2 users must understand that their involvement and upkeep of the system is vital to its existence.

3. Level 3

Level 3 users have a critical responsibility in the Alumni system. These are the users that are responsible for the daily input and upkeep of new information being entered into the system. Level 3 responsibilities include all the responsibilities of the previous two levels plus the responsibility of verifying and validating all data prior to creating a record in the system. Also because of

the ability to delete records, Level 3 users are required to ensure that records that have been marked for deletion are no longer required. Level 3 users will play a big part in the overall success of the Alumni System. Once the database is populated, it is their responsibility to check records and ensure that they are valid, and in the event that they are not, they must correct or delete them. Level 3 persons should realize that the system will only be as good as they make it.

4. Level 4

In addition to the responsibilities of all the previous levels, Level 4 is also responsible for adequately maintaining the system for utilization by authorized users. These users are required to make system modifications when needed, and they act as the direct links to maintenance personnel if a situation occurs that cannot be fixed by the Level 4 user. Level 4 users will ensure that the system is operational and ready for use on a daily basis. Level 4 users will monitor the usage of the other users to ensure that they are adhering to their requirements and responsibilities to the system.

G. SUMMARY

In order to ensure that the requirement analysis being conducted for the alumni system was thorough, several issues had to be confronted, and throughout this chapter we have attempted to do that. The main stakeholders of the system were identified and their interactions with the system, as well as, the average user were detailed in use cases. A database schema was presented to provide a

foundation for how the database will look and the possible relationships that it may contain. Major concerns like security, interaction with preexisting systems, user access, and user responsibility were also detailed throughout the chapter. In addition to identifying the major concerns, possible remedies and recommendations were also provided that could alleviate or even eliminate many of those lingering questions that still exist about the Naval Postgraduate Alumni Database. Results and recommendations were provided to ease the fears and concerns of decision makers. This was done to move them closer to deciding in the favor of approving funding for a more productive system.

V. CONCLUSION

We have thoroughly evaluated the Naval Postgraduate School's Alumni System as part of a process to develop a more effective and efficient one. To facilitate that effort we began by determining the central and most important questions and requirements for having an effective system. We looked at reasons why those specific requirements are important to the alumni system, and we established guides and methods for determining how to answer those questions and fill those system requirements. To ensure that we did not make the same mistakes of previous attempts at designing an effective system, we studied the history of past alumni systems. Throughout that process, we highlighted the problems and successes of those flawed systems, and established an adequate structure for future systems. Once we understood the possible problems that a new system could experience and its requirements, we compared and analyzed the costs and benefits of the options available to the Naval Postgraduate School. The analysis led to the choice of Harris C. Publishing Incorporated as the most desirable of all the alternatives. Overall total cost and net present value were among the chief factors that led to this recommendation.

In addition to determining the most desirable system, identification of the major stakeholders in the system had to be accomplished. A database schema was created to provide a glimpse of the database's structure. Additionally, tables, relationships, domains, and data requirements were provided to assist in establishing a

foundation for future databases. Use cases were designed that detail the step-by-step process of user-system interaction, and provide additional assistance in determining and understanding the requirements of the system. Major security issues were addressed that identify the potential problems, and possible remedies to those issues as well. Finally, user access and responsibility were established to document the standards that each potential user will have to maintain to ensure that the system is successful.

We have developed a set of high-level requirements that any vendor or developer can use as a basis for developing an alumni system. Our efforts have generated what we believe is an effective tool that, if used properly, will assist the Naval Postgraduate School in developing an alumni system that is robust, accurate, and effective.

VI. APPENDIX

A. DATABASE SCHEMA

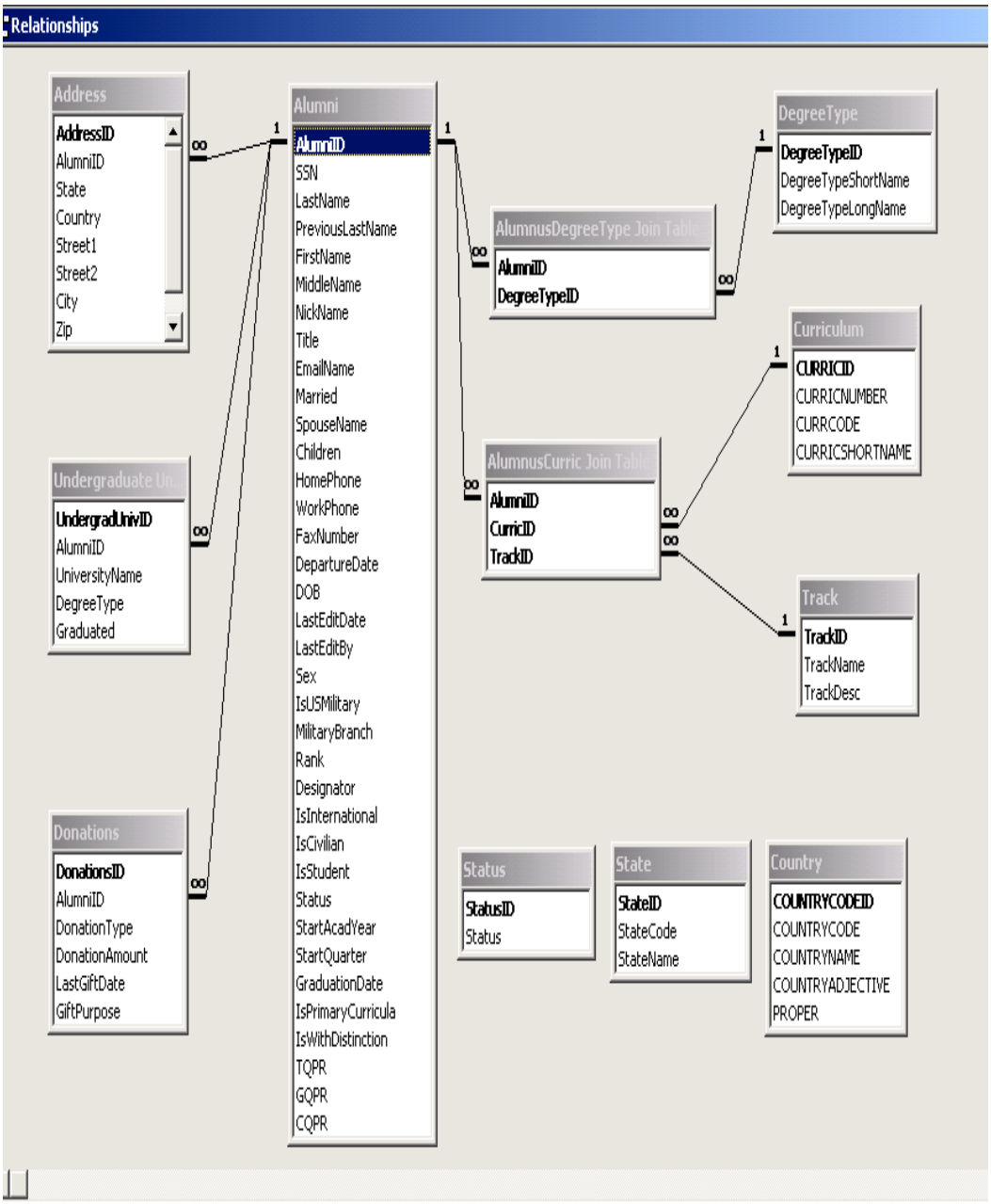

Figure 7. Database Schema

B. BASIC FUNCTIONS

Ref.#/Category	Functions
R1.1/Evident	Customer must register in the system before it can be utilized
R1.2/Evident	Customer must login with an appropriate social security number/identification number and password in order to use the system
R1.3/Hidden	Verification of passwords and social security/identification numbers before allowing access to information
R1.4/Evident	Allow for the creation of new records to the system
R1.5/Evident	Allow for the deletion of unwanted records
R1.6/Evident	Allow individual and group modifications to be made to previously existing records
R1.7/Hidden	Provide an adequate storage mechanism
R1.8/Evident	Provide a platform where information and ideas can be exchanged amongst the system’s users
R1.9/Hidden	Run queries for requested information

Table 16. Use Case Basic Functions

C. BASIC USE CASES

1. Use Case: Login

SECTION: MAIN

Use Case: LOGIN

Actors: All System Users/Customers

Purpose: Prepare the alumni system for use

Overview: A customer/user arrives at a computer terminal to access the alumni system. The user inputs and/or retrieves the required information. At completion, the user leaves with the generated information.

Type: Primary and essential

Cross References: R1.1, R1.2, R1.3

Typical Course of Events:

Actor Action	System Response
1. This use case begins when the customer arrives at a computer terminal to input or retrieve information.	
2. The user logs into the system utilizing a multi-character password.	
	3. Acknowledges and verifies password. Allows user access to the system's data.
4. User proceeds to the main menu of the available system functions.	

Alternative Courses:

Line 2: Invalid password entered. Indicate error upon three invalid attempts, exit the system.

Table 17. Use Case: Login

2. Use Case: Modify A Record

SECTION: MAIN

Use Case: MODIFY AN ALUMNI RECORD

Actors: Customers: Registrar, Alumni Relations Office, School Alumni, NPS Foundation, NPS Departments

Purpose: To update preexisting data in the alumni database

Overview: A customer arrives at a computer terminal to modify a record or records that already exist in the system. The customer inputs the modifying information. The system records and saves the information. Upon completion the user exits the system.

Type: Primary and essential

Cross References: R1.1, R1.2, R1.3, R1.6, R1.7

Use Cases: Customers must have completed the login use case.

Typical Course of Events:

Actor Action	System Response
1. User selects the modify a record option from the main menu.	
	2. System asks if it is this an individual or group modification.
	3. System prompts user to enter social security number or an international alumni identification number.
4. User inputs the required social security/identification number into the system.	
	5. System summons the appropriate record.

Typical Course of Events Continued:

Actor Action	System Response
6. User verifies and makes adjustments to the alumni record and saves the information.	
	7. System saves the information into the database.
9. User clicks exit to leave the modification screen.	
	10. Return user to the main menu.

Alternative Courses:

8. User inputs another valid social security/identification number.

Table 18. Use Case: Modify a Record

3. Use Case: Delete A Record

SECTION: MAIN

Use Case: DELETE AN ALUMNI RECORD

Actors: Customers: Registrar, Alumni Relations Office

Purpose: To delete a record that is resident in the alumni database

Overview: A customer arrives at a computer terminal to remove a preexisting alumni record from the database. The customer recalls the record and removes it from the system. The system records the update. Upon completion the customer exits the system.

Type: Primary and essential

Cross References: R1.1, R1.2, R1.3, R1.5, R1.7

Use Cases: Customers must have completed the login use case.

Typical Course of Events:

Actor Action	System Response
1. User selects the delete a record option from the main menu.	
	2. Delete record screen appears and prompts user to enter social security number or identification number for international alumni.
3. User inputs the required social security/identification number into the system and clicks delete to remove the record.	
	4. System summons the appropriate record and ensures the user wants to delete the record.
5. User verifies and confirms deletion.	

Typical Course of Events Continued:

Actor Action	System Response
	7. System deletes the record, and saves the information into the database.
	8. System prompts user to enter a new record.
9. User clicks exit to leave the deletion screen.	
	10. Return User to the main menu.

Table 19. Use Case: Delete a Record

4. Use Case: Create A Record

SECTION: MAIN
Use Case: CREATE AN ALUMNI RECORD

Actors: Customers: Registrar, Alumni Relations Office, School Alumni

Purpose: To generate a new record that will be maintained in the alumni database

Overview: A customer arrives at a computer terminal to create a new record in the system. The customer inputs the information. The system verifies the information and records it. Upon completion, the customer exits the system.

Type: Primary and essential

Cross References: R1.1, R1.2, R1.3, R1.4

Use Cases: Customers must have completed the login use case

Typical Course of Events:

Actor Action	System Response
1. User selects the create a record option from the main menu.	
	2. New record information screen appears requesting both mandatory and optional information.
3. User inputs the information on the new record.	
	4. System accepts new record information and saves the record in the system.
7. User clicks exit to leave the creation screen.	
	8. Return user to the main menu screen.

Alternative Courses:
5. System rejects record and prompts user for more information.
6. System rejects record because the record is already present in the system.

Table 20. Use Case: Create a Record

5. Use Case: Generate Reports

SECTION: MAIN

Use Case: GENERATE REPORTS

Actors: Customers: Registrar, Alumni Relations Office, NPS Departments

Purpose: To generate and print relevant alumni reports utilizing data obtained and compiled in the alumni database

Overview: A customer arrives at a computer terminal to generate reports from the alumni system. The customer selects the topics and information required. The system acknowledges the information requested and generates the relevant report(s). Upon completion, the customer exits the system and leaves with the reports.

Type: Primary and essential

Cross References: R1.1, R1.2, R1.3, R1.9

Use Cases: Customer must have completed the login use case

Typical Course of Events:

Actor Action	System Response
1. User selects the print reports option from the main menu.	
	2. Print reports screen appears requesting type of report to be generated.
3. User clicks type of report and selects the data to be included in the report.	
	4. System accepts the selections and generates the required report.
5. User clicks exit to leave the print reports screen.	
	6. Return user to the main menu.

Table 21. Use Case: Generate Reports

6. Use Case: Conduct A Survey

SECTION: MAIN

Use Case: CONDUCT A SURVEY/QUESTIONNAIRE

Actors: Customers: Registrar, Alumni Relations Office, NPS Departments

Purpose: To solicit information from NPS Alumni regarding a specified topic or group of topics

Overview: A customer arrives at a computer terminal to solicit responses to a survey/questionnaire that is being conducted. The customer generates a list of persons to receive the survey through the utilization of the alumni database. The system acknowledges the request and generates a list of email accounts, and addresses based on specified criteria. The customer utilizes this information to conduct a survey.

Type: Secondary and essential

Cross References: R1.1, R1.2, R1.3, R1.9

Use Cases: Customers must have completed the login use case

Typical Course of Events:

Actor Action	System Response
1. User selects the conduct a survey option from the main menu.	
	2. Conduct a survey screen appears prompting user to enter survey criteria
3. User inputs the survey criteria.	
	4. System accepts the criteria and generates the survey based on the criteria selected.
5. User clicks exit to leave the conduct a survey screen.	
	6. Return user to the main menu.

Table 22. Use Case: Conduct s Survey

D. ACTOR DIAGRAMS

Figure 8. Actor Diagram (Levels 1&2)

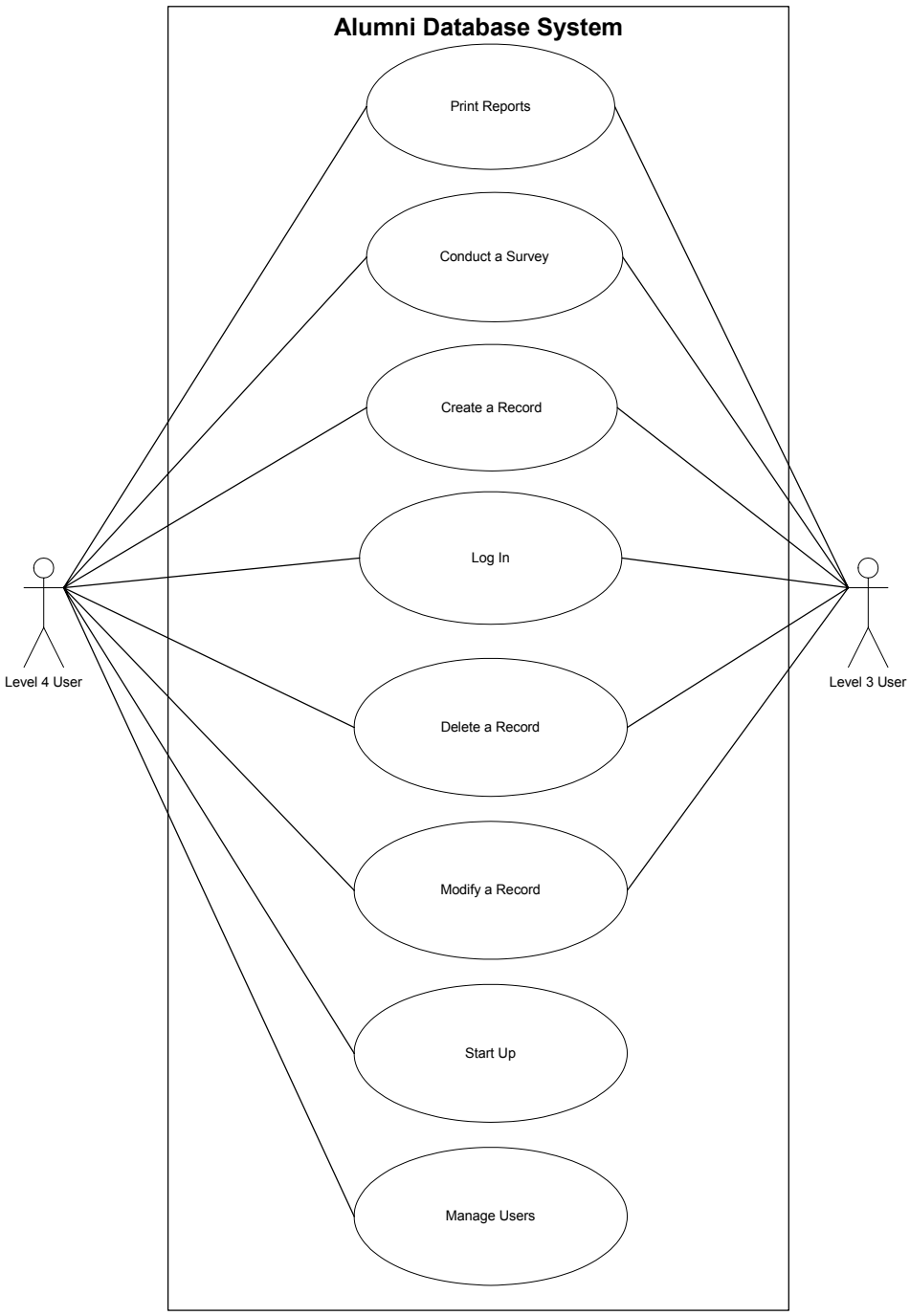

Figure 9. Actor Diagram (Levels 3&4)

E. QUERY LIST

Information obtained from key representative interviews, surveys, and research assisted in compiling a list of queries that could be required of the alumni system. The list is provided in Figure 9.

QUERY	DESCRIPTION
Alumni by class year	Provides a list of alumni by class year
Alumni by country	Provides a list of alumni by country of origin
Alumni by curricula	Provides a list of alumni by curricula studied at NPS
Alumni by city	Provides a list of alumni by city of current residence
Last Name query	Provides a list of alumni by last name
Graduation date query	Provides a list of alumni by date that they graduated
Alumni by race	Provides a list of alumnus by race
Alumni by military	Provides a list of alumnus by military branch
Email address query	Provides a list of alumni and their email addresses
Address & state query	Provides a list of alumni by current address and state

Figure 10. Query List

F. REPORT LIST

Information gathered from interviews with key representatives, survey results, and other research aided in compiling a list of reports that could be required once a new or modified system is completed. This list is provided in Figure 10.

REPORT	DESCRIPTION
Alumni by class year	Provides a list of alumni by class year
Alumni by country	Provides a list of alumni by country of origin
Alumni by curricula	Provides a list of alumni by curricula studied at NPS
Alumni by city	Provides a list of alumni by city of current residence
Last Name query	Provides a list of alumni by last name
Graduation date query	Provides a list of alumni by date that they graduated
Alumnus by race	Provides a list of alumnus by race
Alumnus by military	Provides a list of alumnus by military branch
Alumni by email address	Provides a list of alumni and their email addresses
Alumni by address&state	Provides a list of alumni by current address and state

Figure 11. Reports List

G. ADDITIONAL USE CASES

1. Use Case: Alumni by Graduation Date Report

SECTION: MAIN

Use Case: GENERATE ALUMNI BY GRANDUATION DATE REPORT

Actors: Customer: Student Services

Purpose: To generate a report that lists all NPS alumni and the date that they graduated from the school.

Overview: A customer arrives at a computer terminal to generate reports from the alumni system. The customer selects the report parameters. The system acknowledges the information requested and generates the relevant report(s). Upon completion, the customer exits the system and leaves with the reports.

Type: Primary and essential

Cross References: R1.1, R1.2, R1.3, R1.9

Use Cases: Customer must have completed the login use case

Typical Course of Events:

Actor Action	System Response
1. User selects the print reports option from the main menu.	
	2. Reports screen appears, prompting user to select an option.
3. User selects the required report from the options and enters additional parameters that may be required.	
	4. System accepts the selections and generates the required report.
5. User clicks exit to leave the print reports screen.	
	6. Return user to the main menu.

Table 23. Use Case: Alumni by Graduation Date Report

2. Use Case: Alumni by Email Report

SECTION: MAIN

Use Case: GENERATE ALUMNI BY EMAIL AND ADDRESS REPORT

Actors: Customer: Alumni Relations Office

Purpose: To generate a report that lists all NPS alumni, their email and current address

Overview: A customer arrives at a computer terminal to generate reports from the alumni system. The customer selects the report parameters. The system acknowledges the information requested and generates the relevant report(s). Upon completion, the customer exits the system and leaves with the reports.

Type: Primary and essential

Cross References: R1.1, R1.2, R1.3, R1.9

Use Cases: Customer must have completed the login use case

Typical Course of Events:

Actor Action	System Response
1. User selects the print reports option from the main menu.	
	2. Reports screen appears, prompting user to select an option.
3. User selects the required report from the options and enters additional parameters that may be required.	
	4. System accepts the selections and generates the required report.
5. User clicks exit to leave the print reports screen.	
	6. Return user to the main menu.

Table 24. Use Case: Alumni by Email Address Report

3. Use Case: Alumni by Curricula Report

SECTION: MAIN

Use Case: GENERATE ALUMNI BY CURRICULA REPORT

Actors: Customer: NPS Departments

Purpose: To generate a report that lists all NPS alumni and the curricula that they studied while attending the school

Overview: A customer arrives at a computer terminal to generate reports from the alumni system. The customer selects the report parameters. The system acknowledges the information requested and generates the relevant report(s). Upon completion, the customer exits the system and leaves with the reports.

Type: Primary and essential

Cross References: R1.1, R1.2, R1.3, R1.9

Use Cases: Customer must have completed the login use case

Typical Course of Events:

Actor Action	System Response
1. User selects the print reports option from the main menu.	
	2. Reports screen appears, prompting user to select an option.
3. User selects the required report from the options and enters additional parameters that may be required.	
	4. System accepts the selections and generates the required report.
5. User clicks exit to leave the print reports screen.	
	6. Return user to the main menu.

Table 25. Use Case: Alumni by Curricula Report

4. Use Case: Alumni by Country Report

SECTION: MAIN

Use Case: GENERATE ALUMNI BY COUNTRY REPORT

Actors: Customer: Department of International Programs

Purpose: To generate a report that lists all NPS alumni and their country of origin

Overview: A customer arrives at a computer terminal to generate reports from the alumni system. The customer selects the report parameters. The system acknowledges the information requested and generates the relevant report(s). Upon completion, the customer exits the system and leaves with the reports.

Type: Primary and essential

Cross References: R1.1, R1.2, R1.3, R1.9

Use Cases: Customer must have completed the login use case

Typical Course of Events:

Actor Action	System Response
1. User selects the print reports option from the main menu.	
	2. Reports screen appears, prompting user to select an option.
3. User selects the required report from the options and enters additional parameters that may be required.	
	4. System accepts the selections and generates the required report.
5. User clicks exit to leave the print reports screen.	
	6. Return user to the main menu.

Table 26. Use Case: Alumni by Country Report

5. Use Case: Schieffelin Award

SECTION: MAIN

Use Case: RECEIVE NOMINATIONS FOR SCHIEFFELIN AWARD

Actors: Customers: Registrar, Alumni Relations Office, NPS Foundation, NPS Departments, NPS Alumni

Purpose: To solicit nominations for the Naval Postgraduate School Schieffelin Award

Overview: Customers arrive at computer terminals to both solicit and provide nominations for the NPS Schieffelin Award. The initiating customer generates a survey, and the responding customer inputs a nomination into the system. The system compiles the list of nominations and generates a report. The initiating customer utilizes this information to recommend an award recipient.

Type: Secondary and essential

Cross References: R1.1, R1.2, R1.3, R1.7, R1.8, R1.9

Use Cases: Customers must have completed the login use case

Typical Course of Events:

Actor Action	System Response
1. Initiating customer accesses the broadcast Email application from the main menu.	
	2. The broadcast email screen appears prompting the initiating customer to enter survey criteria.
3. Initiating customer selects a target audience.	
	4. System accepts the criteria.
5. Initiating customer provides detailed instructions and other pertinent information in the broadcast interface.	
	6. System prompts user to select either single (text, html, etc…)or dual (combination) message mode

Typical Course of Events Continued:

Actor Action	System Response
	7. The system acknowledges the customer's selections and provides the requested message form.
8. Initiating customer reviews the message created and submits the broadcast to all potentially responding customers	
	9. The message is broadcasted to alumni per the selected criteria.
10. Potential responding customers receive the broadcasted message. Customers follow the instructions provided, complete, and submit the survey.	
	11. The system receives the submission
12. The initiating customer selects the option to compile the submission.	
	13. System compiles and tallies all submissions received
14. Initiating customer requests report of compiled submission	
	15. System generates the report.
16. Initiating customer receives the report and clicks end to exit the report menu.	
	17. Return user to the main menu.

Table 27. Use Case: Schieffelin Award

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